Chapter C6: Habitat Based Analysis

INTRODUCTION

Aquatic species without primary or direct uses account for the majority of losses at cooling water intake structures (CWIS). These species are not, however, without value to society. It is important to consider the non-use benefits to the human population produced by the increased number of these fish under the final section 316(b) rulemaking.

An alternative way to consider impingement and entrainment (I&E) losses is to value the habitat necessary to replace the lost organisms. The value of fish habitat can provide an indirect basis for valuing the fish that are supported by the habitat. Existing wetland valuation studies found that members of the general public are aware of the fish production services provided by eelgrass (submerged aquatic vegetation, SAV) and wetlands, and that they express support for steps that include increasing SAV and wetland areas to restore reduced fish and shellfish populations (Opaluch et al., 1995, 1998; Mazzotta, 1996).

EPA explored this approach for the North Atlantic region. However, EPA did not include the results of this approach in the benefit analysis because of certain limitations and uncertainties regarding the application of this methodology to the national level. These limitations and uncertainties are discussed in Chapter A15. Thus, this chapter outlines the approach explored by EPA, but does not present benefit estimates.

The approach discussed here uses values that survey respondents indicated for preservation/restoration of eelgrass (SAV), and wetlands to evaluate I&E non-use losses. This analysis is not intended to value directly benefits provided by the lost fish and shellfish, but to provide another perspective on the I&E losses by looking at values of habitat necessary to replace them. The method first estimates the quantity of wetland and eelgrass habitat required to replace fish and shellfish lost to I&E, and then assesses respondents' values for these habitats. These data would then be combined to yield an estimate of household values for improvements in fish and shellfish habitat, which provides an indirect estimate of the benefits of reducing or eliminating I&E. However, EPA does not present benefit estimates.

This benefit transfer approach involves four general steps, which are described in detail in Chapter A15:

1. Estimate the amount of restored wetlands and/or eelgrass needed to produce organisms at a level necessary to offset I&E losses for the subset of species for which potential production information is available.
2. Develop willingness-to-pay (WTP) values for fish production services of wetlands and eelgrass ecosystems.
3. Estimate the total value of baseline I&E losses by multiplying the WTP values for fish and shellfish services of restored wetlands and eelgrass by the number of acres of each needed to offset I&E losses.
4. Estimate the total benefits of the final section 316(b) rule, in terms of the value of decreased I&E losses, by multiplying the WTP values for fish and shellfish services of restored habitat by the number of acres of each habitat type needed to offset decreased I&E losses.

The rest of this chapter describes EPA's exploratory application of this method to the North Atlantic region.

C6-1 DATA SUMMARY

For each habitat type, EPA used available fish sampling data for the habitats of interest to determine the number of acres required to offset I&E losses. To estimate public WTP, EPA used information from two studies of public values for wetlands and eelgrass: a study of the Peconic Estuary, located on the East End of Long Island, New York (Johnston et al., 2001a, 2001b; Opaluch et al., 1995, 1998; Mazzotta, 1996); and a stated preference study from Narragansett Bay, Rhode Island (Johnston et al., 2002). These studies are described in detail in Chapter A15.

EPA based the benefit transfer of both total and non-use values for fish habitat provided by eelgrass and wetlands on the Peconic Estuary study.[1] The valuation of fish habitat services provided by wetlands was based on the Johnston et al. (2002) study.

C6-2 BENEFIT TRANSFER FOR THE NORTH ATLANTIC REGION

C6-2.1 Estimating the Amount of Wetlands and Eelgrass (SAV) Needed to Offset Losses for Specific Species

The first step in the analysis involves calculating the area of habitat needed to offset I&E losses for the subset of species for which restoration of these habitats was identified by local experts as the preferred restoration alternative, and for which production information is available (i.e., the habitat that will produce the equivalent quantity of fish impinged and entrained at CWIS). Habitats that support fish and shellfish include seagrasses, tidal wetlands, coral reefs, and estuarine soft-bottom sediments. The analysis may also consider man-made habitat enhancements, such as artificial reefs or fish passageways. The most suitable habitat restoration option was selected for each affected species.

Table C6-1 presents the fish species impinged and entrained in the North Atlantic region, along with an indication of whether SAV, tidal wetland, or some other habitat restoration action was identified as the preferred method for offsetting I&E losses by the expert panel. Of the 18 fish species lost to I&E in the region, experts determined that losses of 3 species would be best offset by tidal wetland restoration, and losses of a further 3 species would be best offset by SAV restoration.

Table C6-2 presents estimated age 1 equivalent densities in wetland or SAV habitat for the six fish species for which restoration of these habitats was identified as the preferred alternative for offsetting I&E losses.[2] These estimates are derived from abundance data for these species in wetland and SAV habitats. Abundance data were used because estimates of production rates in these habitats were not available for the species of interest. Individuals were counted within subsampling areas of the habitats (e.g., 100 square meters), and the resulting counts were scaled up to derive per acre density estimates by species.

Using a typical restoration scaling rule, the estimates of the acres of required SAV and wetlands restoration reflect the acreage needed for the species requiring the maximum quantity of habitat restoration to offset its I&E losses. For the Brayton Point case study, the amount of tidal wetland restoration is based on the number of acres needed to offset losses to winter flounder. The amount of SAV restoration is based on the acreage needed for scup.

For any given species, the number of acres of restored habitat needed to offset I&E losses is determined by dividing the species average annual age 1 equivalent I&E loss by its estimated abundance per acre in that habitat.

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[1] Conducted in 1995, the Peconic study provides information for the Peconic Estuary Program's Comprehensive Conservation and Management Plan (Peconic Estuary Program, 2001).

[2] Specific data sources for these estimates and details of data analyses are provided in Chapters F5 and G5 of the section 316(b) Phase II Case Study Document.

Table C6-1: Average Annual Age 1 Equivalent I&E Losses and Preferred Habitat Restoration Alternative (SAV or Tidal Wetland) for I&E Species Lost in the North Atlantic Region

I&E Species	Preferred Habitat Restoration Alternative
Winter flounder	tidal wetland
Atlantic silverside	tidal wetland
Striped killifish	tidal wetland
Threespine stickleback	SAV
Weakfish	SAV
Scup	SAV
Seaboard goby	other
Bay anchovy	other
American sand lance	other
Hogchoker	other
Rainbow smelt	other
Alewife	other
Tautog	other
Silver hake	other
Atlantic menhaden	other
Windowpane	other
White perch	other
Butterfish	other

Table C6-2: Estimated Age 1 Equivalent Densities in Tidal Wetland and SAV for I&E Species

Species	Tidal Wetland Age 1 Equivalent Density, Fish/Acre[a,b,c]	SAV Age 1 Equivalent Density, Fish/Acre[a,b,d]	
		Low Sampling Gear Efficiency	High Sampling Gear Efficiency
Winter flounder	205	n/a	
Atlantic silverside	202		
Striped killifish	721		
Threespine stickleback		3,031	699
Weakfish	n/a	no abundance data	
Scup		21	5

[a] Differences in the abundance estimates for a specific species between Brayton Point and Pilgrim reflect incorporation of differences in site-specific life history.
[b] Abundance estimates per unit of habitat are rounded to the nearest fish.
[c] A single abundance estimate is calculated from the incorporation of a point estimate of gear sampling efficiency.
[d] The range of abundance estimates reflects incorporation of alternative estimates of sampling gear efficiency.

C6-2.2 Developing WTP Values for Fish Production Services Provided by Submerged Aquatic Vegetation and Wetlands

EPA based the benefit transfer of both total and non-use values for fish habitat provided by eelgrass and wetlands on the Peconic Estuary study, described in Chapter A15.

C6-2.2.1 Wetland values for fish habitat services

a. Methodology for estimating the proportion of wetland value attributable to fish habitat

Because coastal wetlands provide a number of services (e.g., habitat, water purification, storm buffering, and aesthetics), EPA attempted to separate values for fish habitat from values for other wetland services. Given survey data available from the Peconic study, however, there is no direct means to estimate the proportion of total wetland value associated with fish habitat services alone. EPA therefore used the stated preference study from Narragansett Bay, Rhode Island, described in Chapter A15, to adjust wetland values to reflect fish habitat services (Johnston et al., 2002). The calculation of adjustment factors is also described in Chapter A15.

b. Applicability of the Narragansett Bay study's value proportions to the Peconic study's total wetland values

As noted above, no direct means is available for assessing the exact proportion of Peconic wetland values associated with fish habitat services. However, the Johnston et al. (2002) value proportions provide a reasonable, average approximation, based on a random-sample survey of Rhode Island residents. As with any type of benefit transfer, the applicability of the Johnston et al. (2002) value proportions to the Peconic wetland values depends on certain assumptions. The primary assumptions concern the approximate constancy of value *proportions* with respect to changes in policy scale.

Unlike the Peconic survey, which addressed total and marginal wetland values over large, long-term changes in wetland acreage (i.e., up to 4,000 acres over the entire Peconic region), the Rhode Island study estimates restoration values over the scale of a single salt water wetland (i.e., between 3 and 12 acres). Although this difference in scale is likely to influence the marginal WTP for wetland preservation or restoration, EPA does not expect the difference in scale to significantly influence the proportion of marginal WTP associated with fish habitat services. That is, the Agency assumed that if fish habitat services each account for approximately 25 percent of the total value for the tenth acre of restoration in a region, then each service will also account for approximately 25 percent of value for the hundredth or thousandth acre in the same region, even though the total value of each acre, on the margin, may change. That is, the assumption of fixed value proportions associated with fish habitat services concerns only the *relative* proportion of value associated with fish habitat, which may remain constant even as the absolute marginal value of a wetland acre diminishes with scale.[3]

A second key assumption of this analysis is that residents of the Peconic region and residents of Rhode Island maintain similar relative values with respect to the services provided by salt water wetlands. Although this presumption cannot be proven using results from Johnston et al. (2002) or Opaluch et al. (1995, 1998), and while value proportions may differ to a small degree, there is no overriding reason to suspect (and the literature results do not suggest) that relative value proportions would differ to a significant degree across the two sites.

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[3] Technical note regarding the robustness of value proportions: Following standard practice (e.g., Adamowicz et al., 1998), the survey's underlying model results are based on an orthogonal array of attribute levels. No imposed functional linkage exists between wetland size and habitat services. This independence is preserved by the linear form of the utility function. The model therefore allows one to vary wetland size and habitat services independently when estimating public values, even if such independence is highly unlikely in real situations. This specification allows the researcher a large degree of leeway when specifying "reasonable" restoration scenarios. It also allows the valuation of clearly unrealistic scenarios in which, for example, the restoration of huge wetlands provides negligible habitat gains. In such unrealistic scenarios, it is possible to illustrate cases in which proportions of value diminish to a significant degree as wetland size increases. However, if one specifies more realistic scenarios in which increases in restored wetland acreage and resulting increases in habitat services change (approximately) proportionately, then the proportion of wetland values associated with fish habitat is robust. That is, assuming that the marginal gain in habitat (fish, shellfish, etc.) provided by the tenth acre of restoration is equivalent to the gain provided by the hundredth acre, the proportion of value associated with fish will remain constant as one increases the scale of restoration.

Finally, while the Johnston et al. study enumerates a number of wetland functions, the Peconic study does not enumerate specific wetlands functions, but assumes that respondents are valuing all functions of wetlands, as they perceive and understand them. Based on the similarities, including vegetation, wetland size, water body characteristics, and population characteristics, between the Peconic Estuary and Narragansett Bay, it is reasonable to assume that services of wetlands are similar in the two regions, and that people will have similar values and rankings for such services.

C6-2.2.2 Values per acre of SAV and wetlands for the Peconic Estuary

a. Wetlands values for fish habitat services in the Peconic Estuary

EPA first multiplied the value per household by the proportion of wetlands value attributed to fish habitat, to get the value per acre per household for fish habitat services of wetlands. The Agency then multiplied this value per acre by the total number of households in the Peconic study area (73,423), yielding the value per acre of wetlands for the population surrounding the Peconic Estuary. Table C6-3 shows these values.

The Peconic study defined the affected population as the total number of households (both year-round and seasonal) in the five towns bordering the Peconic Estuary. As noted above, this definition of the study area results in conservative total values because it does not include the values for people who live on Long Island beyond these five towns, the values for visitors to the area, or anyone else. For example, past visitors to Long Island and residents of New York or elsewhere who've never even been to Long Island might all hold some value for preserving its resources. For the Peconic Estuary region, the total annual value per acre for fish habitat services of wetlands is $1,053, whereas the total non-use value only is $1,009.[4]

Table C6-3: Estimated WTP Values for Fish Habitat Services Provided by Wetlands from the Peconic Study (2002$)		
	$/HH/Acre/Year[a]	Total WTP/Acre/Year[b]
Total Value	$0.014	$1,053
Non-Use Value[c]	$0.014	$1,009

[a] Values shown are WTP per household per *additional* (i.e, marginal) acre per year.
[b] Total WTP per acre is calculated as household WTP per acre times 73,423 total households in the study area.
[c] Total non-use value is calculated as value per acre for non-users only times all households in the region.

b. Eelgrass values for fish habitat services in the Peconic Estuary

Multiplying the value per household by the total number of households in the Peconic study area (73,423) yields the value per acre of eelgrass for the population surrounding the Peconic Estuary. Table C6-4 shows these values. The study defined the benefit population as the total number of households (both year-round and seasonal) in the five towns bordering the Peconic Estuary. For the Peconic Estuary region, the total annual value per acre for eelgrass is $4,656; and the total non-use only value is $3,837.[5]

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[4] This analysis assumes that non-use values are the same for both users and non-users of the affected resources. Some studies found that users of the resource have higher non-use values than non-users. This may result from additional information about water resources associated with past or expected future use, which is likely to enhance non-use values (Whitehead and Blomquist, 1991b). The data, however, do not allow us to evaluate non-use values specific to users.

[5] This analysis assumes that non-use values are the same for both users and non-users of the affected resources. Users of the resource likely have higher non-use values than non-users, but the data do not allow us to test this hypothesis.

Table C6-4: Estimated WTP Values for Eelgrass (SAV) from the Peconic Study (2002$)[6]		
	$/HH/Acre/Year[a]	**Total WTP/Acre/Year**[b]
Total Value	$0.063	$4,656
Non-Use Value[c]	$0.052	$3,837

[a] Values shown are WTP per household per *additional* (i.e, marginal) acre per year.
[b] Total WTP per acre is calculated as household WTP per acre times 73,423 total households in the study area.
[c] Total non-use value is calculated as value per acre for non-users only times all households in the study area.

C6-2.3 Applicability of Study Area to Policy Area

In the Peconic study, corrections were made to WTP values to account for differences in demographics between survey respondents and the general population of the East End of Long Island. EPA compared demographics of the affected population for one North Atlantic facility — the Brayton Point Station — to demographics of the East End of Long Island. Households in the Brayton Point region (Bristol County, MA; Newport County, RI; and Bristol County, RI) are quite similar to those of the general population of the East End. Table C6-5 compares survey respondent demographics to residents of the East End and residents of the Brayton Point region, based on education and income categories used to estimate WTP. The Brayton Point region has slightly lower education levels, and slightly higher income levels, on average, than the Peconic region. While values presented in the analysis were adjusted to the Peconic levels, they could be easily re-adjusted to reflect New England levels. However, based on the small differences in demographics between the regions, the effect is likely to be negligible.

Table C6-5: Comparison of Demographics							
	Ed. 1-3[a]	**Ed. 4**[a]	**Ed 5-7**[a]	**Inc. 1-2**[b]	**Inc. 3,4**[b]	**Inc. 5-7**[b]	**Inc. 8**[b]
Brayton Region	52.75%	16.63%	30.62%	28.62%	26.18%	41.47%	3.72%
Peconic	50.76%	18.35%	30.9%	33.77%	33.77%	30.86%	3.41%
Survey	16.86%	21.26%	61.88%	17.05%	17.05%	46.4%	5.61%

[a] Ed. 1-3 = high school graduate or less; Ed. 4 = some college; Ed. 5-7 = associate's, bachelor's or advanced degree.
[b] Inc. 1-2 = $24,999 or less; Inc. 3-4 = $25,000-$49,999; Inc. 5-7 = $50,000-$149,999; Inc. 8 - $150,000 and over.

C6-2.4 Determining the Affected Population

Evaluating the total value per acre of wetlands and SAV for the coastal population of the region requires a definition of the geographical extent of the affected population. The Peconic study defined the affected population as the total number of households in the towns bordering the Peconic Estuary. Similarly, as described in Chapter A15, EPA defines the affected population as households residing in the counties that abut affected water bodies. These households are likely to value gains of fish in the affected water body, due to their close proximity to the affected resource. As discussed further in Chapter A15, households in counties that do not directly abut the affected water body will also likely value the water body's resources.

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[6] EPA made dollar value adjustments using the Consumer Price Index (CPI) for all urban consumers for the first half of 2003 (U.S. Bureau of Labor Statistics, 2003).

C6-2.5 Habitat Values per Acre for the Affected Population

The total value per acre for the affected population is calculated by multiplying the value per acre per household by the total number of affected households.

C6-2.6 Estimating the Value of Habitat Needed to Offset I&E Losses for the Region

Due to limitations and uncertainties that make this valuation approach difficult to implement on a regional scale, EPA does not present aggregate values for I&E losses. These values would be calculated by multiplying the total number of acres of each habitat required to offset losses by the value per acre for the affected population.

C6-3 LIMITATIONS AND UNCERTAINTY

A number of issues are common to all benefit transfers. Benefit transfer involves adapting research conducted for another purpose in the available literature to address the policy questions at hand. Because benefits analysis of environmental regulations rarely affords enough time to develop original stated preference surveys that are specific to the policy effects, benefit transfer is often the only option to inform a policy decision. Specific issues associated with this approach are discussed in Chapter A15.